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Computational Study of a Pulsed Power Source based Electromagnetic Manufacturing Process

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Electromagnetic Manufacturing (EMMa) is one of the newer manufacturing techniques which is gaining popularity. It uses an intense transient magnetic field generated by a pulsed power source to apply a transient force on the work piece and deform it without any direct mechanical contact. For an optimal choice of the pulsed power parameters for the EMMa, an understanding of the electromagnetic, mechanical, material and thermal phenomena associated with this type of manufacturing is imperative. A good understanding of the coupled effects of electromagnetic and mechanical forces and how they affect the material and thermal properties of the material is required to estimate the deformation taking place on the work piece. It requires numerical modelling of the forming process as well as to apply suitable numerical models to predict the relevant physical phenomenon.

EMMa system use a coil to apply the required electromagnetic force on the work piece during the discharge of a capacitor bank. In case of a multi-turn coil, the mechanical stress generated in the coil also needs to be studied. The coil design influences the distribution of the electromagnetic forces both on the work-piece as well as the coil. The pulsed current flowing through the coil also results in significant amount of heat being generated in the coil. The challenging feature of the numerical modelling of the deformation process and its effect on the coil is solving a highly coupled system of partial differential equations.

Therefore, in the present work, a numerical technique has been developed to model the EMMa process and to simulate the transient effects of the pulsed magnetic field on the work-piece and the coil. Specific attention is given to the study of the important process parameters, and the effect of their mutual interaction. The results would be presented and discussed in the final paper.

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